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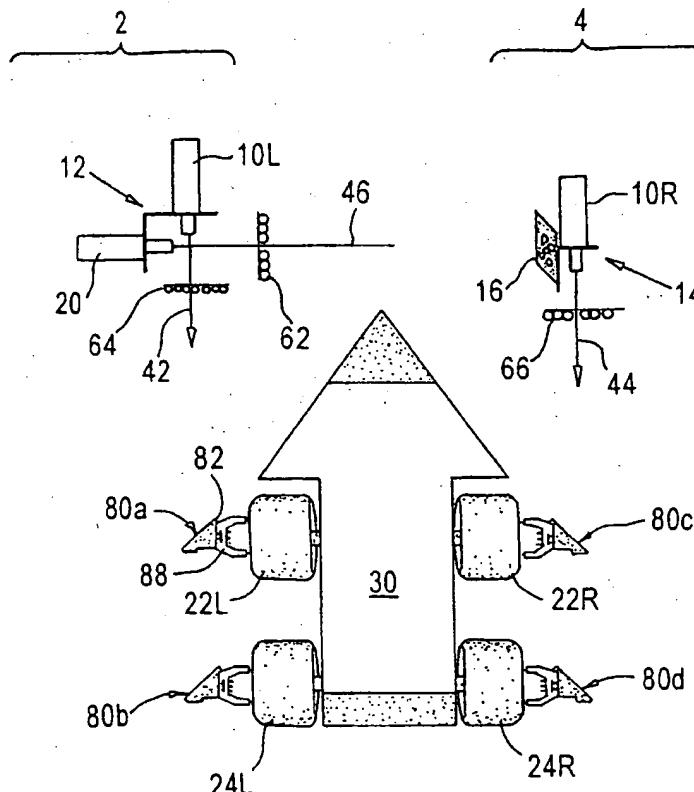
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(54) Title: SELF-CALIBRATING, MULTI-CAMERA MACHINE VISION MEASURING SYSTEM



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(57) Abstract: An apparatus and method for calibrating machine vision measuring systems that have more than one camera are disclosed. A first calibration target is mounted in a fixed relationship to a first camera of the machine vision measuring system. A third camera mounted in a fixed relationship to a second camera of the machine vision measuring system. Second and third calibration targets are mounted in a fixed relationship to one another and viewable by the first camera and by the third camera. A data processor is programmed to compute calibration of the first camera and the second camera, based on a position of the second calibration target relative to the third calibration target and based on a position of the first camera with respect to the third camera. The apparatus and method provide a way to continuously measure the positions of two or more cameras used in the measuring system, and to use such measurements to calibrate the system. If the cameras move with respect to each other, their respective positions are calculated and used in subsequent measurements. The apparatus and method enable a machine vision measuring system to be used without field calibration at the time of installation.



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B. FIELDS SEARCHED

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Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 764 992 A (GRANGER ROMAIN) 24 December 1998 (1998-12-24) the whole document ---	1,19,21, 36,38
X,P	WO 00 16121 A (QUALISYS AB) 23 March 2000 (2000-03-23) the whole document & SE 9 803 102 A (QUALISYS AB) 12 March 2000 (2000-03-12) ---	1,19,21, 36,38
P,X	EP 1 003 011 A (EUROP D EQUIPEMENTS DE GARAGE) 24 May 2000 (2000-05-24) the whole document ---	1,19,21, 36,38
A	EP 0 149 690 A (ALPHA TECHNOLOGIES LTD) 31 July 1985 (1985-07-31) the whole document ---	19,21 -/-

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 40 41 723 A (KOESTER BERND ; THIEDIG ULLRICH (DE); WENTE HOLGER (DE)) 25 June 1992 (1992-06-25)	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
FR 2764992 A	24-12-1998	NONE		
WO 0016121 A	23-03-2000	SE	515134 C	11-06-2001
		AU	6236599 A	03-04-2000
		SE	9803102 A	12-03-2000
EP 1003011 A	24-05-2000	FR	2786268 A	26-05-2000
EP 0149690 A	31-07-1985	NONE		
DE 4041723 A	25-06-1992	WO	9211442 A	09-07-1992
		DE	59106873 D	14-12-1995
		EP	0564535 A	13-10-1993